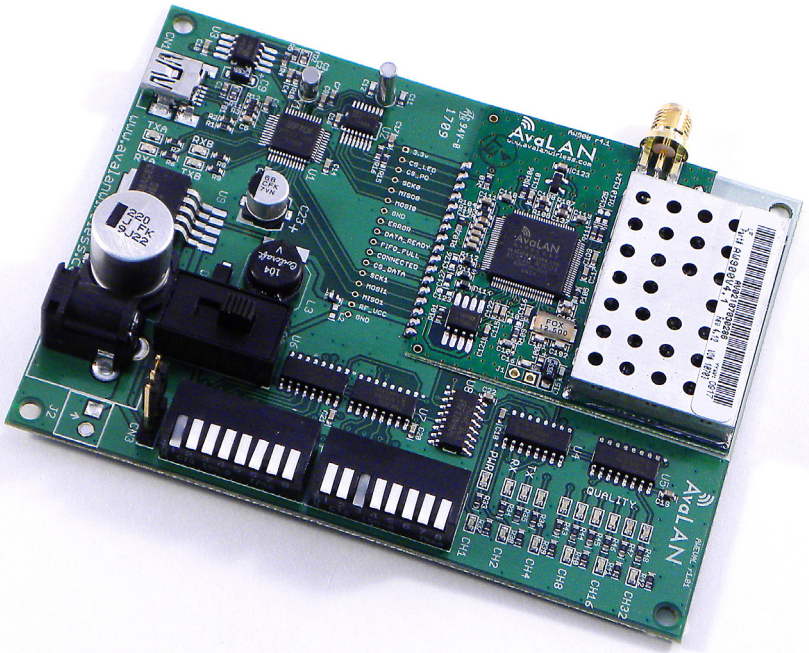


AW900mSPI and AW900mSPI-EVAL

USER'S MANUAL

900 MHz Digital Radio Transceiver Module and Evaluation Kit With SPI or UART Data Interface

Industrial-grade, long-range wireless Ethernet systems

AvaLAN WIRELESS

Thank you for your purchase of the AW900mSPI 900 MHz Digital Radio Transceiver Module w**ith SPI or UART Data Interface.**

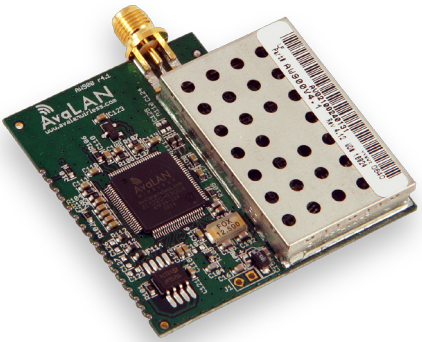
The Module itself may be ordered in quantities of ten as the AW900mSPI-10.

The **AW900mSPI-EVAL Evaluation Kit** includes:

- (2) Evaluation controller PC Boards with AW900mSPI Radio Modules mounted on them
- (2) 120 VAC to 12 VDC power adapters and (1) Battery Pack
- (2) USB Cables
- (2) Omni-directional antennas with 8" RPSMA to RPTNC RF Cables

Firmware and software described in this manual may be downloaded from **www.avalanwireless.com/downloads.htm**. (You can also find a pdf of the latest version of this manual.)

If you have any questions when configuring your AvaLAN system, the best place to get answers is to visit www.avalanwireless.com. If more assistance is needed, send email to support@avalanwireless.com. To speak to a live technician, please call technical support at the number below during normal business hours.



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Features and Specifications

- 1.54 Mbps DSSS Radio with High Speed SPI and UART Data Interfaces
- FCC/IC Certified modular approval
- 128 Bit AES Encryption – FIPS 197 NIST Certified
- 148 dB link budget at 900 Mhz enables exceptional range
- 4 Watts EIRP with 15 dBi antennae (+21 dB conducted)
- -112 dB receiver sensitivity with 15 dBi antennae (-98dB at port)
- TDMA MAC supports up to 63 concurrent subscribers
- Low power consumption: 0.75 Watts in transmit, 0.5 Watts in receive, 100 µW in standby
- Wide Temperature range: -40° to +85° C
- Narrow occupied bandwidth allows 12 channels at 900 Mhz
- Small form factor allows easy integration: 47.5 x 51 x 7 mm, 10 grams
- Frequency Channels: 2.0833 MHz spacing and 1.75 MHz occupied bandwidth

Channel	Center Frequency - MHz
0	Automatic Selection
1	903.1250
2	905.2083
3	907.2917
4	909.3750
5	911.4583
6	913.5417
7	915.6250
8	917.7083
9	919.7917
10	921.8750
11	923.9583
12	926.0417

Technical Summary

The AW900mSPI modules from AvaLAN Wireless have an on-board Baseband processor, the XC1220 from AvaLAN Wireless. The XC1220 handles all RF timing, data buffering, AES encryption, RF data transfers and statistics gathering. The XC1220 must be connected to a host microcontroller via a Serial Peripheral Interface (SPI) or a Universal Asynchronous Receiver/Transmitter (UART). AvaLAN's packaged radios, such as the AW900XTR, include a host microcontroller that provides an Ethernet interface. The purpose of this RF-only module is to allow you to create other applications and interfaces with your own electronics.

The host microcontroller is responsible for configuring the keys that the XC1220 uses for RF communication/encryption, as well as transferring data to and from the XC1220. The XC1220 features an 8kB transmit FIFO and a 5kB receive FIFO. The RF communication topology that the modules use is a point to multipoint star topology. There is one RF master Access Point (AP) and up to 63 RF slave Subscriber Units (SU).

Data from the AP can be sent to one specific SU or broadcast to all SUs. Broadcast data has no retransmissions and is not guaranteed to reach all SUs. Data from an SU is always sent to the AP with retransmissions.

Data is divided up into blocks for RF transmission. This division of the data allows for better interference immunity and re-transmission performance.

The digital interface to the AW900mSPI may be SPI or UART, depending upon which firmware is running in the XC1220.

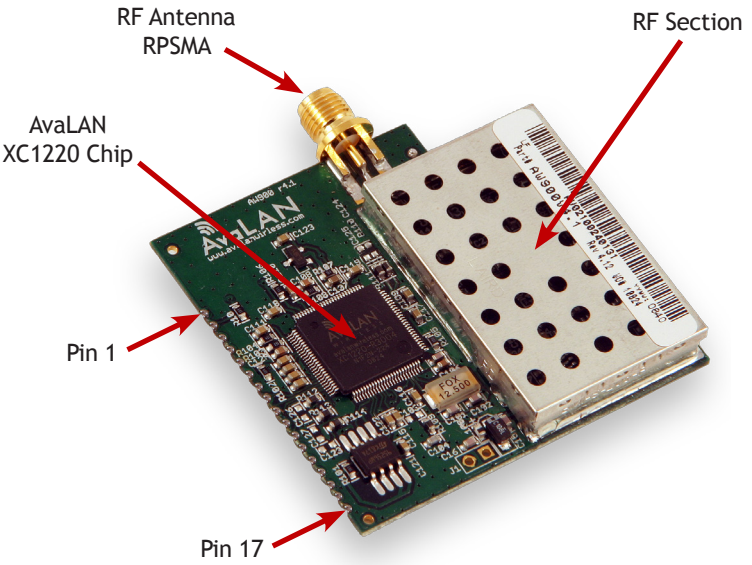
Serial Peripheral Interface (SPI) is a full duplex synchronous serial interface. SPI is a master-slave interface, with the master providing the synchronous clock.

Universal Asynchronous Receiver/Transmitter (UART) is an asynchronous serial interface that allows data to be transmitted without a clock signal, but the sender and receiver of the data must agree in advance on the timing parameters and special bits are added to each data byte to synchronize the sending and receiving units.

Selecting SPI or UART:

The choice of interface is up to the user and governed by the user's application and the nature of the host microcontroller. UART is more common, being closely related to RS-232. It is also places fewer demands on the host microcontroller. The UART interface is limited to 115,200 bits per second, while SPI may be run as high as 7 megabits per second. Whether the AW900mSPI uses SPI or UART is a choice that is controlled at boot up. By connecting a 10K resistor from Pin 8 (Error Flag) to Vcc (pull up), the AW900mSPI will boot up in UART mode. If the resistor is connected instead to ground (pull down), it will boot up in SPI mode.

Module Physical Interface



Module SPI Interfaces

Serial Peripheral Interface (SPI) is a full duplex synchronus serial interface that allows data to be shifted in and out of the AvaLAN Baseband Processor (XC1220) 8 bits at a time, most significant bit first.

Each SPI requires 4 pins to be physically connected:

- SCK – Serial bit shift clock (provided by master SPI)
- MISO – Master In Slave Out
- MOSI – Master Out Slave In
- CS – Active low Chip Select

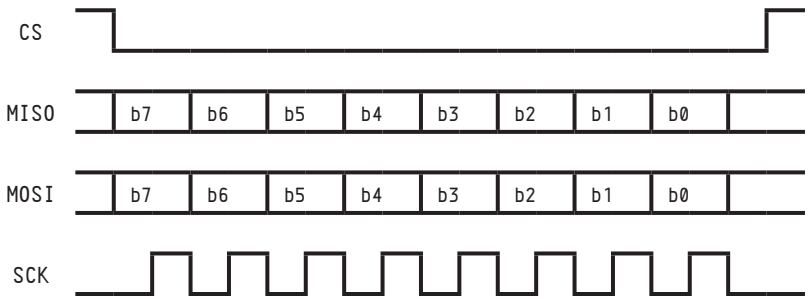
There are two SPI interfaces on the AW900mSPI. The first is a master SPI (SPI0), operating LEDs and DIP switches. SPI0's connections are pins 3-6. The second is a slave SPI (SPI1) for management of the radio link, statistics, firmware upgrading, and data transfers. SPI1's connections are on pins 12-15.

Here are the Signal definitions for the AW900SPI in SPI mode:

Pin Number	Name	Description
1	Vcc	3.3 vdc for XC1220
2	/CS_LED	Chip select for LEDs and DIP switches (active low)
3	/CS_PD	Chip select for external programming device
4	SCK0	Serial clock for LEDs and DIP switches
5	MISO0	Data in for LEDs and DIP switches
6	MOSI0	Data out for LEDs and DIP switches
7	GND	XC1220 Ground
8	Error Flag	1=last command not understood. Clear with /CS_BB
9	Data Ready	1=data packet available, 0=no data
10	FIFO Full Flag	1=FIFO full, don't send any more data, 0=FIFO is empty
11	Connected Flag	1=RF connection present, 0=RF searching/standby
12	/CS_BB	Chip select for XC1220
13	SCK1	Serial clock for XC1220
14	MOSI1	Data out for XC1220
15	MISO1	Data in for XC1220
16	RFVcc	3.3 vdc for RF section
17	RFGND	RF section ground

SPI0 uses mode (0,0) for clock phase and polarity. This means that the SCK0 line idles low and data is setup on the falling edge of the clock and latched on the rising edge. SPI1 uses mode (1,1), meaning that SCK1, MISO1 and MOSI1 are all idle high. Data is still set up on the falling edge and latched on the rising edge of the clock.

The clock rate for the SPI0 interface is 1.5625 MHz. The maximum clock rate for the SPI1 interface is 7 MHz and the minimum clock rate is 530 kHz (minimum clock period of 143 ns and a maximum of 1887 ns).

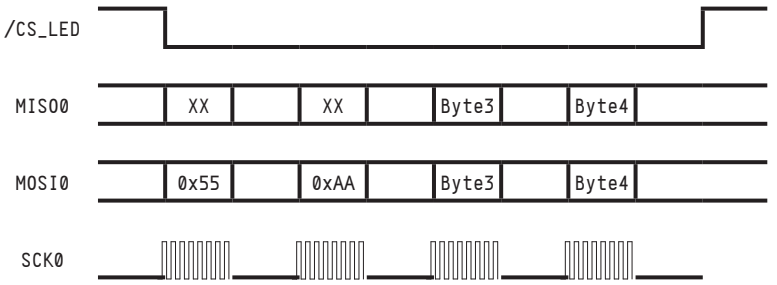


SPI0 - LEDs and DIP Switches

SPI0 is a master mode SPI that sends out 4 bytes per transaction. The first two bytes are alignment bytes and the last two contain the LED data on MOSI0, and the DIP switch data on MISO0.

The first alignment byte is 0x55, and the second is 0xAA. These two bytes are used to determine the start of the transaction (0x55) and the start of the data (0xAA).

LEDs:



A bit that is set in either of these bytes indicates that the corresponding LED should be on.

Byte3	b7	b6	b5	b4	b3	b2	b1	b0
	PWR	RX_ACT	LCH5	LCH4	LCH3	LCH2	LCH1	LCH0

PWR: Turns on when the firmware is running. In troubleshoot mode PWR changes states on the AP every time a search for more SUs takes place. On a SU PWR changes state every time the SU responds to a search for more SUs.

RX_ACT: Indicates when data traffic has been received by the RF. RX_ACT will be set for 32ms when data has been successfully received.

LCH5..0: Indicates what RF channel is currently in use. In troubleshoot mode these bits indicate what the unit's device ID is.

Byte4	b7	b6	b5	b4	b3	b2	b1	b0
	TX_ACT	-	RFQ5	RFQ4	RFQ3	RFQ2	RFQ1	RFQ0

TX_ACT: Indicates when data traffic is queued up for transmission across the RF.

TX_ACT will be set for 32ms when data is queued up for transmission.

RFQ5..0: Indicates the quality of the RF link. The lowest quality is only b0 set, the highest quality is reached when b5 is set.

DIPs:

A bit that is set in this byte indicates that the corresponding DIP switch is on.

Byte3	b7	b6	b5	b4	b3	b2	b1	b0
	DCH5	DCH4	DCH3	DCH2	DCH1	DCH0	MODE	-

DCH5..0: Used to set the radio into manual channel mode and use the channel indicated. If DCH5..0 are all clear then the radio will be in automatic mode.

MODE: When set the unit is in troubleshooting mode, when clear the unit is in normal operation.

SPI1 - Command Interface

SPI1 is a slave mode SPI, meaning SCK is supplied by an external source. This SPI is used to configure the module, read status information, issue firmware upgrades and transfer data.

The first byte on the MOSI line after the /CS_BB line goes low is the Command Byte. This byte tells the XC1220 what command is to be executed.

Command Byte:

b7	b6	b5	b4	b3	b2	b1	b0
get/set	-	-	-	CMD3	CMD2	CMD1	CMD0

get/set: When set this bit indicates that information will be sent to the XC1220 on MOSI1 and MISO1 will be high impedance. When clear a get transaction will take place and information will be sent from the XC1220 on MISO1.

After the command byte is issued the master microcontroller must delay for at least 4 µs to allow the XC1220 enough time to prepare for the transaction.

When a transaction is complete and the /CS_BB line is high, the master microcontroller must delay for at least 6 µs to allow the XC1220 to finish processing the transaction.

CMD3..1: These bits are used to tell the XC1220 what command is to be executed.

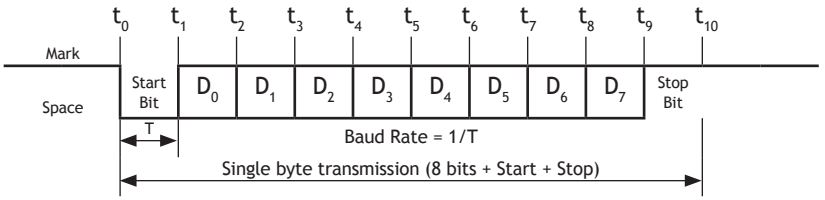
Module UART Interface

Here are the Signal definitions for the AW900SPI in UART mode:

Pin Number	Name	Description
1	Vcc	3.3 vdc for XC1220
2	/CS_LED	Chip select for external programming device
3	/CS_PD	Chip select for LEDs and DIP switches (active low)
4	SCK0	Serial clock for LEDs and DIP switches
5	MISO0	Data in for LEDs and DIP switches
6	MOSI0	Data out for LEDs and DIP switches
7	GND	XC1220 Ground
8	NC	Not Used
9	NC	Not Used
10	NC	Not Used
11	NC	Not Used
12	NC	Not Used
13	NC	Not Used
14	MOSI1	UART TX
15	MISO1	UART RX
16	RFVcc	3.3 vdc for RF section
17	RFGND	RF section ground

In UART mode, the AW900mSPI's command interface is moved to SPI0. The LEDs and DIP switches may still be employed, but the primary purpose of this SPI port has shifted. SPI1 now becomes an asynchronous UART with TX on pin 14 and RX on pin 15 and is used for data that is transmitted and received via the RF.

At the risk of belaboring what is obvious and familiar to most engineers because of the long history of RS-232, the UART signals consist of a set of bits sent with a pre-defined clock rate. The sender must agree on what the rate is, and because the sender's clock and receiver's clock may not exactly agree, synchronization information is sent with each byte of data:



The Stop Bit can actually be any duration and provides the variable delay that allows synchronization between sender and receiver. Sometimes, the Stop Bit is

specified to be at least two intervals. Also, sometimes a Parity Bit is sent between D_7 and the Stop Bit, but this is rarely done anymore.

UART Mode LEDs and DIPs:

With the UART firmware running, the LED definitions are the same as for SPI mode and provide diagnostic information if desired.

The DIP switch definitions are slightly different:

	b7	b6	b5	b4	b3	b2	b1	b0
Byte3			DCH3	DCH2	DCH1	DCH0	MODE	-
Byte4						TEST		

MODE: 1 = Access Point, 0 = Subscriber Unit

DCH3 to DCH0: 4-bit binary code for the RF channel selected. (All zeros means use automatic channel switching.)

TEST: 1 = Continuous traffic for site survey testing, 0 = normal operation.

Module Command Set

The Command Sets for SPI and UART modes are somewhat different:

SPI Command Set	
Command Byte - HEX	Command
0x01	getStatus
0x02	getNetworkKey
0x03	getPrivateKey
0x04	getDeviceID
0x05	getStats
0x06	getVersion
0x07	not valid
0x08	getNumberofConnectedSUs
0x09	getRSSIreadings
0x0A	getDATAPacket
0x81	setStatus
0x82	setPublicKey
0x83	setPrivateKey
0x84	setDeviceID
0x85	setReset
0x86	not valid
0x87	not valid
0x88	not valid
0x89	not valid
0x8A	setDATAPacket
0x8B	setFirmwareStart
0x8C	setFirmwareEnd

UART Command Set	
Command Byte - HEX	Command
0x00	getStatus
0x01	getNetworkKey
0x02	getPrivateKey
0x03	getDeviceID
0x04	getStats
0x05	getVersion
0x06	getConfig
0x07	getNumberofConnectedSUs
0x08	getRSSIreadings
0x09	not valid
0x80	setStatus
0x81	setPublicKey
0x82	setPrivateKey
0x83	setDeviceID
0x84	setReset
0x85	not valid
0x86	not valid
0x87	not valid
0x89	not valid
0x8B	setDATAPacket

In the Command Descriptions that follow, the command codes for each mode are shown in the byte tables.

Status Command

The **getStatus** command is used to find out the current status of the module.

getStatus		SPI Mode: 0x01			UART Mode: 0x00			
Byte 1	b7	b6	b5	b4	b3	b2	b1	b0
	RFState	Radio	-	-	CH3	CH2	CH1	CH0

RFState: When set this bit indicates that the RF is currently connected.

Radio: Indicates what mode the radio is in, when set it is in active mode. When clear the RF is in standby mode.

CH3..0: Indicates what channel the RF is currently using.

The **setStatus** command is used to place the module in standby mode/normal operation and to set the RF into manual channel mode by assigning a specific channel.

setStatus		SPI Mode: 0x81			UART Mode: 0x80			
Byte 1	b7	b6	b5	b4	b3	b2	b1	b0
	-	Radio	-	-	CH3	CH2	CH1	CH0

Radio: Setting this bit places the radio in active mode, clearing it places it in standby mode.

CH3..0: When these bits are cleared the radio is in automatic channel mode. When any of these bits are set the radio will be in manual channel mode and use the channel indicated by these bits if it is valid.

Channel	CH3	CH2	CH1	CH0	Frequency - MHz
1	0	0	0	1	903.1250
2	0	0	1	0	905.2083
3	0	0	1	1	907.2917
4	0	1	0	0	909.3750
5	0	1	0	1	911.4583
6	0	1	1	0	913.5417
7	0	1	1	1	915.6250
8	1	0	0	0	917.7083
9	1	0	0	1	919.7917
10	1	0	1	0	921.8750
11	1	0	1	1	923.9583
12	1	1	0	0	926.0417

Network Key Command

The Network Key is A 32-bit number used for Network Identification. AvaLAN m-series devices with different Network Keys will not be able to communicate with each other. The Network Key can be changed without resetting the device.

The **getNetworkKey** command will read back the last 32-bit key issued to the device.

The **setNetworkKey** command stores a new 32-bit key to be used for RF communications.

getNetworkKey		**SPI Mode:** 0x02			**UART Mode:** 0x01			
setNetworkKey		**SPI Mode:** 0x82			**UART Mode:** 0x81			
	b7	b6	b5	b4	b3	b2	b1	b0
Byte 1	PK7	PK6	PK5	PK4	PK3	PK2	PK1	PK0
Byte 2	PK15	PK14	PK13	PK12	PK11	PK10	PK9	PK8
Byte 3	PK23	PK22	PK21	PK20	PK19	PK18	PK17	PK16
Byte 4	PK31	PK30	PK29	PK28	PK27	PK26	PK25	PK24

Private Key Command

The Private Key is the 128-bit key used in the AES encryption of data transmitted over the RF. This key must be set once at start up and cannot be changed without resetting the device. If two or more radios have the same Public Key but different Private Keys, they will connect with each other. However, the received data will be completely scrambled.

The **getPrivateKey** command reads back the private key issued at startup.

The **setPrivateKey** command stores the private key to be used for the AES encryption. This command should be issued only once at start up. If issued again with a different key, data corruption will occur.

getPrivateKey		**SPI Mode:** 0x03			**UART Mode:** 0x02			
setPrivateKey		**SPI Mode:** 0x83			**UART Mode:** 0x82			
	b7	b6	b5	b4	b3	b2	b1	b0
Byte 1	SK7	SK6	SK5	SK4	SK3	SK2	SK1	SK0
Byte 2	SK15	SK14	SK13	SK12	SK11	SK10	SK9	SK8

Byte 3	SK23	SK22	SK21	SK20	SK19	SK18	SK17	SK16
Byte 4	SK31	SK30	SK29	SK28	SK27	SK26	SK25	SK24
Byte 5	SK39	SK38	SK37	SK36	SK35	SK34	SK33	SK32
Byte 6	SK47	SK46	SK45	SK44	SK43	SK42	SK41	SK40
Byte 7	SK55	SK54	SK53	SK52	SK51	SK50	SK49	SK48
Byte 8	SK63	SK62	SK61	SK60	SK59	SK58	SK57	SK56
Byte 9	SK71	SK70	SK69	SK68	SK67	SK66	SK65	SK64
Byte 10	SK79	SK78	SK77	SK76	SK75	SK74	SK73	SK72
Byte 11	SK87	SK86	SK85	SK84	SK83	SK82	SK81	SK80
Byte 12	SK95	SK94	SK93	SK92	SK91	SK90	SK89	SK88
Byte 13	SK103	SK102	SK101	SK100	SK99	SK98	SK97	SK96
Byte 14	SK111	SK110	SK109	SK108	SK107	SK106	SK105	SK104
Byte 15	SK119	SK118	SK117	SK116	SK115	SK114	SK113	SK112
Byte 16	SK127	SK126	SK125	SK124	SK123	SK122	SK121	SK120

Device ID Command

The Device ID command has two uses depending on whether the device is configured as an access point (AP) or subscriber unit (SU.) In either case, the Device ID is a 6-bit number, allowing a maximum ID of 63. The Device ID must be issued at start up and must not be changed without resetting the device.

For the AP the Device ID is the maximum SU ID that is allowed to connect to the RF network.

For the SU the Device ID is the individual ID number assigned to the device. This ID number is used as an address during data transfers.

The **getDeviceID** command reads back the configured ID.

The **setDeviceID** command configures the device to be either an AP or an SU and what ID to use.

getDeviceID		**SPI Mode:**	0x04		**UART Mode:**		0x03	
setDeviceID		**SPI Mode:**	0x84		**UART Mode:**		0x83	
	b7	b6	b5	b4	b3	b2	b1	b0
Byte 1	D1	D0	MID5	MID4	MID3	MID2	MID1	MID0

D1, D0: These bits report or configure whether the device is an AP or an SU:

D1	D0	Mode
0	0	Not Configured
0	1	AP
1	0	AP
1	1	SU

MID5..0: These bits read back or set the configured ID. For an AP this is the maximum ID number that is allowed to join the RF network. For an SU it is the number to use to join the RF network.

Stats Command

The **getStats** command is used to gather all the statistics that the XC1220 is collecting about the RF link. The statistics are, total number of packets transferred, total number of packets that failed to make it across the RF, total number of packets that successfully made it across the RF, total number of broadcast packets, total number of unicast packets, average transmitted packet size in the last 32 packets, average received packet size in the last 32 packets, and percentage block error rate.

The statistics can be read from the XC1220 at any time during normal operation.

getStats		**SPI Mode:** 0x05			**UART Mode:** 0x04			
	b7	b6	b5	b4	b3	b2	b1	b0
Byte 1	TP23	TP22	TP21	TP20	TP19	TP18	TP17	TP16
Byte 2	TP31	TP30	TP29	TP28	TP27	TP26	TP25	TP24
Byte 3	TP7	TP6	TP5	TP4	TP3	TP2	TP1	TP0
Byte 4	TP15	TP14	TP13	TP12	TP11	TP10	TP9	TP8
Byte 5	FP23	FP22	FP21	FP20	FP19	FP18	FP17	FP16
Byte 6	FP31	FP30	FP29	FP28	FP27	FP26	FP25	FP24
Byte 7	FP7	FP6	FP5	FP4	FP3	FP2	FP1	FP0
Byte 8	FP15	FP14	FP13	FP12	FP11	FP10	FP9	FP8
Byte 9	PP23	PP22	PP21	PP20	PP19	PP18	PP17	PP16
Byte 10	PP31	PP30	PP29	PP28	PP27	PP26	PP25	PP24

Byte 11	PP7	PP6	PP5	PP4	PP3	PP2	PP1	PP0
Byte 12	PP15	PP14	PP13	PP12	PP11	PP10	PP9	PP8
Byte 13	BC23	BC22	BC21	BC20	BC19	BC18	BC17	BC16
Byte 14	BC31	BC30	BC29	BC28	BC27	BC26	BC25	BC24
Byte 15	BC7	BC6	BC5	BC4	BC3	BC2	BC1	BC0
Byte 16	BC15	BC14	BC13	BC12	BC11	BC10	BC9	BC8
Byte 17	UC23	UC22	UC21	UC20	UC19	UC18	UC17	UC16
Byte 18	UC31	UC30	UC29	UC28	UC27	UC26	UC25	UC24
Byte 19	UC7	UC6	UC5	UC4	UC3	UC2	UC1	UC0
Byte 20	UC15	UC14	UC13	UC12	UC11	UC10	UC9	UC8
Byte 21	ATX7	ATX6	ATX5	ATX4	ATX3	ATX2	ATX1	ATX0
Byte 22	ATX15	ATX14	ATX13	ATX12	ATX11	ATX10	ATX9	ATX8
Byte 23	ARX7	ARX6	ARX5	ARX4	ARX3	ARX2	ARX1	ARX0
Byte 24	ARX15	ARX14	ARX13	ARX12	ARX11	ARX10	ARX9	ARX8
Byte 25	BER7	BER6	BER5	BER4	BER3	BER2	BER1	BER0
Byte 26	BER15	BER14	BER13	BER12	BER11	BER10	BER9	BER8

Bytes 1 to 4 are the 32-bit total number of packets sent and received (TP0 to TP31).

Bytes 5 to 8 are the 32-bit total number of failed packets sent and received (FP0 to FP31).

Bytes 9 to 12 are the 32-bit total number of passed packets sent and received (PP0 to PP31).

Bytes 13 to 16 are the 32-bit total number of broadcast packets sent and received (BC0 to BC31).

Bytes 17 to 20 are the 32-bit total number of unicast packets sent and received (UC0 to UC31).

Bytes 21 and 22 are the 16-bit average transmitted packet size over the last 32 packets (ATX0 to ATX15).

Bytes 23 and 24 are the 16-bit average received packet size over the last 32 packets (ARX0 to ARX15).

Bytes 25 and 26 are the 16-bit percentage block error rate. BER15..8 is the integer

part and ranges from 0 to 100. BER7..0 is the 2-digit fractional part and ranges from 0 to 99. The block error rate is calculated over the last 1000 data blocks.

Version Command

The **getVersion** command is used to determine the firmware version running in the XC1220.

getVersion		**SPI Mode:** 0x06			**UART Mode:** 0x05			
	b7	b6	b5	b4	b3	b2	b1	b0
Byte 1	RFV3	RFV2	RFV1	RFV0	PV3	PV2	PV1	PV0
Byte 2	RV7	RV6	RV5	RV4	RV3	RV2	RV1	RV0
Byte 3	RV15	RV14	RV13	RV12	RV11	RV10	RV9	RV8

PV0 to PV3 is the 4-bit product version number.

RFV0 to RFV3 is the 4-bit radio version number.

RV0 to RV15 is the 16-bit firmware release version number.

Connected SUs Command

The **getNumberofConnectedSUs** command is used on the AP only, if issued on the SU it will return all zeros. It returns the current number of SUs that are connected to the RF network (5-bit number, CC0 to CC4).

getNumberofConnectedSUs			**SPI Mode:** 0x08			**UART Mode:** 0x07		
	b7	b6	b5	b4	b3	b2	b1	b0
Byte 1	x	x	x	CC4	CC3	CC2	CC1	CC0

RSSI Command

The **getRSSIReadings** command is used to determine if possible interference exists in the RF environment. The AW900mSPI can perform a spectrum analysis scan, stepping through the frequency band and measuring the peak and average power received at each frequency. Note: When two or more radios are actively linked, the AP will tell the SUs to cease transmitting when it goes into spectrum scan mode. However, when an SU scans, it will likely see a peak transmission from another radio.

The host microcontroller sends the resolution settings to the XC1220, then gets

channel information back from the XC1220. The host microcontroller must delay while the XC1220 completes the scan before reading any data. In SPI mode, the XC1220 will use the Data Ready line (pin 9) to indicate when the scan is complete and the data is available. In UART mode, the host microcontroller needs to issue the command and wait for data to be returned.

getRSSIReadings		**SPI Mode:** 0x09			**UART Mode:** 0x08			
	b7	b6	b5	b4	b3	b2	b1	b0
Byte 1	SS3	SS2	SS1	SS0	EXP3	EXP2	EXP1	EXP0

Note that this command is an exception to the general rule that "get" commands receive data and "set" commands send it. This command must be followed by sending one byte of configuration information and then reading back a variable number of data bytes.

SS0 to SS3 is the frequency step size (valid numbers are 1, 2, 4, 8).

EXP0 to EXP3 is the base-2 exponent of the number of samples to collect and average together at each frequency step.

EXP3...0	Number of Samples
0	1
1	2
2	4
3	8
4	16
5	32
6	64
7	128
8	256

The number of samples and frequency step size affects the amount of time it takes to scan the band. A step size of 1 and exponent of 8 takes approximately 2 seconds to scan the band. A step size of 8 and exponent of 32 takes approximately 300ms to scan.

Although a higher step size and lower exponent scan much faster, a complete picture of the band may not be formed. Devices that only transmit for a very short period of time may be missed with a fast scan.

	b7	b6	b5	b4	b3	b2	b1	b0
Byte 2	BASE7	BASE6	BASE5	BASE4	BASE3	BASE2	BASE1	BASE0
Byte 3	BASE15	BASE14	BASE13	BASE12	BASE11	BASE10	BASE9	BASE8

BASE is a 16-bit integer constant that provides the index offset for establishing the RF frequency. For the AW900mSPI, this value is 1688.

	b7	b6	b5	b4	b3	b2	b1	b0
Byte 4	NUM7	NUM6	NUM5	NUM4	NUM3	NUM2	NUM1	NUM0
Byte 5	DEN7	DEN6	DEN5	DEN4	DEN3	DEN2	DEN1	DEN0

NUM and DEN are 8-bit integer constants used to calculate the frequency value corresponding to each index step. For the AW900mSPI, NUM = 25 and DEN = 48.

Frequency in MHz = (Index + BASE) * NUM / DEN

Where Index is an integer value starting with zero. For example, the lowest transmit channel for the AW900mSPI corresponds to an Index of 46:

(46 + 1688) * 25 / 48 = 903.125 MHz

	b7	b6	b5	b4	b3	b2	b1	b0
Byte 6	MAX7	MAX6	MAX5	MAX4	MAX3	MAX2	MAX1	MAX0

MAX is an 8-bit integer constant that represents the number of RF channels that the radio uses. For the AW900mSPI, this value is 12. It is important to save this number because it tells you how many bytes of data to read next:

	b7	b6	b5	b4	b3	b2	b1	b0
Byte 7	MK7	MK6	MK5	MK4	MK3	MK2	MK1	MK0
Byte 8	MK15	MK14	MK13	MK12	MK11	MK10	MK9	MK8
...	Repeat MAX times to read all the values							

MK is a 16-bit integer that contains the Index value for each RF channel. Bytes 7 and 8 will repeat until MAX values have been read. (For the AW900mSPI, this will total 24 bytes, Byte7 through Byte30.)

	b7	b6	b5	b4	b3	b2	b1	b0
Byte 31	DP7	DP6	DP5	DP4	DP3	DP2	DP1	DP0

Byte 32	DP15	DP14	DP13	DP12	DP11	DP10	DP9	DP8

DP is the 16-bit integer number of data points in the spectrum scan. The value will depend upon the frequency step size specified in Byte1. The next 4 data bytes will be repeated DP times.

	b7	b6	b5	b4	b3	b2	b1	b0
Byte 33	OFS7	OFS6	OFS5	OFS4	OFS3	OFS2	OFS1	OFS0
Byte 34	OFS15	OFS14	OFS13	OFS12	OFS11	OFS10	OFS9	OFS8
Byte 35	PEAK7	PEAK6	PEAK5	PEAK4	PEAK3	PEAK2	PEAK1	PEAK0
Byte 36	AVG7	AVG6	AVG5	AVG4	AVG3	AVG2	AVG1	AVG0
...	Repeat DP times to read all the spectrum data							

OFS is the 16-bit integer Index value for this data point. The range of this index is 0 to (128 – Frequency Step Size). For example, with a step size of 1, the maximum value of OFS is 127, but with a step size of 8, the maximum value is 120.

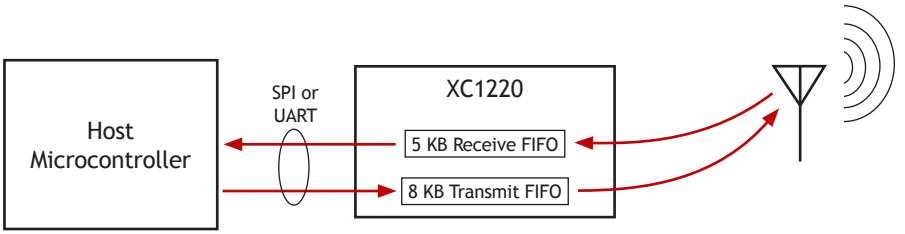
PEAK is an 8-bit integer representing the peak power detected at each frequency.

AVG is an 8-bit integer representing the average power detected at each frequency.

Both the PEAK and AVG readings are a logarithmic scale, with a value of zero corresponding to -100 dBm and a value of 255 corresponding to -15 dBm:

$$\text{Power in dBm} = -(100 - ((\text{Sample Value}) / 3))$$

Please be aware that this scale is approximate. Linearity is poor above -20 dBm or below -90 dBm.



Data Commands

The data commands are used to transfer data between the XC1220 and the host microcontroller that is intended for RF transmission.

The XC1220's receive FIFO does not have data protection. This means that when data is received from the RF, the host microcontroller has up to 50ms to remove the data from the FIFO before data corruption occurs.

The transmit FIFO does utilize data protection. If the host microcontroller attempts to send data to the XC1220 while the transmit FIFO is full (indicated to the host microcontroller using the FIFO_Full line) the data will be discarded. Please note that in UART mode, there is no FIFO_Full line. Because the UART baud rate is much slower than the radio's transmit rate, transmit overflow should not occur.

Data from the AP can be sent to one specific SU or broadcast to all SUs. Broadcast data has no retransmissions and is not guaranteed to reach all SUs. Data from an SU is always sent to the AP with retransmissions. Data is divided up into blocks for RF transmission. This division of the data allows for better interference immunity and re-transmission performance.

The **getPacket** command is used to read received data from the XC1220. The Data Ready line (pin 9) will be asserted when data is present in the receive FIFO and will remain asserted until all data is read. Once the Data Ready line has been asserted the host microcontroller has approximately 50ms until the data becomes corrupted in a high traffic scenario. Obviously in UART mode, the host microcontroller must be ready to receive data at any time.

getPacket		**SPI Mode:**		0x0A	**UART Mode:**			N/A
	b7	b6	b5	b4	b3	b2	b1	b0
Byte 1	-	ID6	ID5	ID4	ID3	ID2	ID1	ID0
Byte 2	S7	S6	S5	S4	S3	S2	S1	S0
Byte 3	-	-	-	-	-	S10	S9	S8
Byte 4	DATA7	DATA6	DATA5	DATA4	DATA3	DATA2	DATA1	DATA0
...	Byte 4 is repeated until all the data is received							

ID0 to ID6 is the 7-bit integer Device ID of the Subscriber Unit the data was received from (Access Point only, for a Subscriber Unit the data is undefined).

S0 to S10 is the 11-bit integer size of the Data packet in bytes (number of data bytes to read).

The **setPacket** command is used to submit data to the transmit FIFO for RF transmission. The FIFO Full line (Pin 10) will be asserted if the transmit FIFO cannot accept any more data. If the host microcontroller attempts to submit data while the FIFO Full line is asserted then the Error Flag will also become asserted and the data being submitted will not be entered into the FIFO. In UART mode, the host

microcontroller is responsible for avoiding overflow.

setPacket		SPI Mode:	0x8A		UART Mode:			0x89
	b7	b6	b5	b4	b3	b2	b1	b0
Byte 1	BC	ID6	ID5	ID4	ID3	ID2	ID1	ID0
Byte 2	S7	S6	S5	S4	S3	S2	S1	S0
Byte 3	-	-	-	-	-	S10	S9	S8
Byte 4	DATA7	DATA6	DATA5	DATA4	DATA3	DATA2	DATA1	DATA0
...	Byte 4 is repeated until all the data is sent.							

BC is the Broadcast Flag. BC = 1 means send the packet to all Subscriber Units. BC = 0 means send the packet only to the Device ID specified in the rest of Byte 1.

ID0 to ID6 is the 7-bit integer Device ID of the Subscriber Unit that is to receive the data. Note that if BC = 1 and there is a non-zero Device ID specified, then all Subscribers **but** the one specified will receive the data.

S0 to S10 is the 11-bit integer size of the Data packet in bytes (number of data bytes being sent).

Reset Command

The **setReset** command is used to reset the XC1220 and can be issued at any time durning normal operation. After a reset has been issued the XC1220 takes approximately 300 ms to restart. After restart all previously configured data (Public and Private Keys, Device ID and type) will be lost.

setReset	SPI Mode:	0x85	UART Mode:	0x84

There are no other bytes required to reset the device. The host microcontroller should simply issue the **setReset** command.

Firmware Upgrading

If an update of the AW900mSPI's firmware becomes desirable, a new firmware image will be supplied by AvaLAN. If a USB interface exists, such as that used in the EVAL board and recommended for UART applications, then the firmware upgrade will be handled by a software utility provided by us. If the AW900mSPI is used in SPI mode and you wish to build firmware update into your host microcontroller's code,

here is how to do it.

The following information applies to SPI Mode only:

Once a **setFirmwareStart** (0x8B) command has been issued to the XC1220, all other commands except for **setPacket** (0x8A) and **setFirmwareEnd** (0x8C) become invalid and will cause the Error Flag to assert if they are issued. The host microcontroller must deassert the /CS_BB line (pin 12) and then wait for a minimum of 5 µs and the DATA Ready line (pin 9) to be asserted before reasserting /CS_BB to send the first data block.

The firmware image is partitioned into data blocks with a payload size of 64 bytes. Each block is sent as it's own transaction and must use the **setPacket** command to be issued to the XC1220. Since data can be submitted to the XC1220 faster than it can be stored in flash, the FIFO Full line must be carefully observed to make sure none of the blocks are lost.

If the last firmware block is not a full 64 bytes, it must be padded with zeros.

setPacket		**SPI Mode:**	0x8A					
	b7	b6	b5	b4	b3	b2	b1	b0
Byte 1	BC	ID6	ID5	ID4	ID3	ID2	ID1	ID0
Byte 2	S7	S6	S5	S4	S3	S2	S1	S0
Byte 3	-	-	-	-	-	S10	S9	S8
Byte 4	OFS7	OFS6	OFS5	OFS4	OFS3	OFS2	OFS1	OFS0
Byte 5	OFS15	OFS14	OFS13	OFS12	OFS11	OFS10	OFS9	OFS8
Byte 6	DATA7	DATA6	DATA5	DATA4	DATA3	DATA2	DATA1	DATA0
Byte 7	DATA15	DATA14	DATA13	DATA12	DATA11	DATA10	DATA9	DATA8
...	Bytes 6 and 7 are repeated 32 times.							
Byte 70	CHK7	CHK6	CHK5	CHK4	CHK3	CHK2	CHK1	CHK0
Byte 71	CHK15	CHK14	CHK13	CHK12	CHK11	CHK10	CHK9	CHK8

BC must be set and ID0 to ID6 must be clear. (Byte 1 is 0x80.)

S0 to S10 must be set to 68. (Byte 2 is 0x44 and Byte3 is 0x00.)

OFS0 to OFS15 is the 16-bit integer firmware block number. This value will be included in the checksum calculation.

DATA0 to DATA15 is the 16-bit firmware data, 32 values per block.

CHK0 to 15 is the 16-bit integer checksum value for the block. It is calculated in the host microcontroller as follows:

1. Initialize a 16-bit register to 0x1911.
2. Add the 16-bit data value to the register beginning with the firmware block number.
3. Perform a rotate left with no carry by 5 bit positions.
4. Repeat steps 2 and 3 for all 34 words (OFS and DATA).

Once all blocks have been submitted to the XC1220, then the host microcontroller must issue the **setFirmwareEnd** (0x8C) command. Once the **setFirmwareEnd** command has been issued to the XC1220, the host microcontroller must wait for the programming to complete. The XC1220 will indicate this by deasserting the Data Ready line (pin 9). Once the Data Ready line is deasserted, programming is complete and it is safe to reset the XC1220 with the **setReset** command (0x85). A reset is required before the XC1220 will begin executing the new firmware image.

Programming Examples

Note that these examples apply to SPI mode.

Initialization Example

To initialize the XC1220 follow these steps:

1. At startup delay for 300 ms to allow the XC1220 enough time to initialize.
2. Assert /CS_BB (drive the line low) and issue **setNetworkKey** (0x82) command and delay for 4 µs.
3. Send 3 bytes with 24-bit Network Key value.
4. Deassert /CS_BB (drive the line high) and delay for 6 µs.
5. Assert /CS_BB and issue **setPrivateKey** (0x83) command and delay for 4 µs.
6. Send 16 bytes with 128-bit Private Key value.
7. Deassert /CS_BB and delay for 6 µs.
8. Assert /CS_BB and issue **setDeviceID** (0x84) command and delay for 4 µs.
9. Send one byte indicating what type of device and ID number.
10. Deassert /CS_BB and delay for 6 µs.
11. Assert /CS_BB and issue **setStatus** (0x81) command and delay for 4 µs.
12. Send one byte with bit 6 set to take radio out of standby mode.

13. Deassert /CS_BB.
14. Wait for Connected Flag to be set

The AW900mSPI is now initialized and connected, ready to send and receive data.

Send Data Example (AP Side)

1. If Connected Flag is clear or FIFO Full Flag is set then end.
2. Else assert /CS_BB (drive line low) and issue **setPacket** (0x8A) command and delay for 4 µs.
3. Send first byte indicating if a broadcast packet or a unicast packet.
4. Send two bytes indicating data size in bytes.
5. Send all data bytes
6. Deassert /CS_BB (drive line high) and delay for 6 µs.

Get Data Example (AP Side)

1. If Data Ready Flag is set assert /CS_BB (drive line low) and issue **getPacket** (0x0A) command and delay for 4 µs.
2. Gets first byte to determine what SU sent the packet.
3. Get next two bytes to determine the packet size in bytes.
4. Get all data bytes
5. Deassert /CS_BB (drive line high) and delay for 6 µs.
6. If Data Ready is still set then repeat all steps.

RSSI Example

1. Assert /CS_BB (drive line low) and issue **getRSSIreadings** (0x09) command and delay for 4 µs.
2. Send first byte to tell XC1220 what step size and number of samples to use.
3. Get two bytes to determine the Base Frequency multiplier.
4. Get two bytes to determine the Numerator and Denominator for frequency calculations.
5. Get one byte to determine how many channel markers there are.
6. Get all channel markers.
7. Wait for Data Ready to be set.
8. Get two bytes to determine the number of data points to be read.

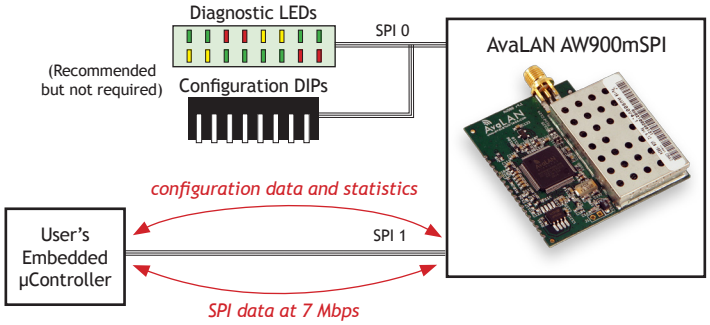
9. Get four bytes for Step Number, Peak Power, and Average Power.
10. Repeat step 9 for all data points.
11. Deassert /CS_BB (drive line high) and delay for 6 µs.

Firmware Update Example

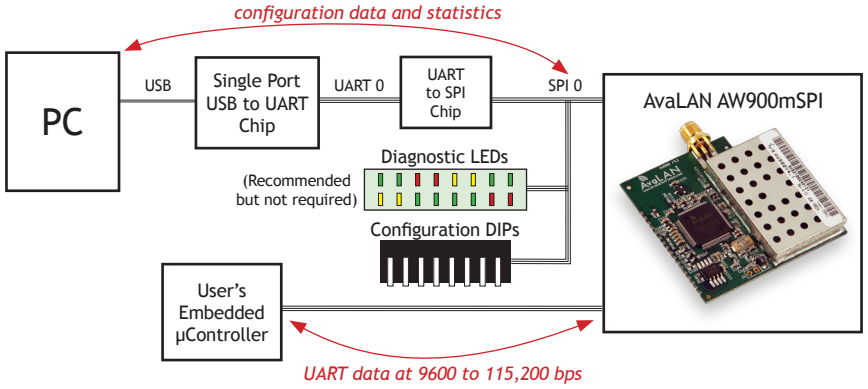
1. Assert /CS_BB (drive line low) and issue **setFirmwareStart** (0x8B) command and deassert /CS_BB (drive line high).
2. Delay for 5 µs.
3. Wait for Data Ready to be asserted.
4. While FIFO Full is set wait.
5. Assert /CS_BB and issue **setPacket** (0x8A) command and delay for 4 µs.
6. Send first byte as 0x80
7. Send next two bytes as 0x44 and 0x00 respectively, for packet size of 68.
8. Send two bytes to indicate Firmware block offset of following payload.
9. Send 64 payload bytes.
10. Send two bytes for checksum.
11. Delay 4 µs then check Error Flag.
12. If Error Flag is clear then deassert /CS_BB and delay for 4 µs. Prepare next Firmware block and loop to Step 4.
13. Else if Error Flag is set then deassert /CS_BB and delay for 4 µs. Loop to Step 4.
14. Repeat steps 4 to 13 until all firmware blocks have been sent.
15. Once all blocks have been sent assert /CS_BB and issue **setFirmwareEnd** (0x8C) command and deassert /CS_BB.
16. While Data Ready flag is set wait.
17. Assert /CS_BB and issue **setReset** (0x85) command and deassert /CS_BB.

Implementation Block Diagrams

Suggested SPI User Implementation:

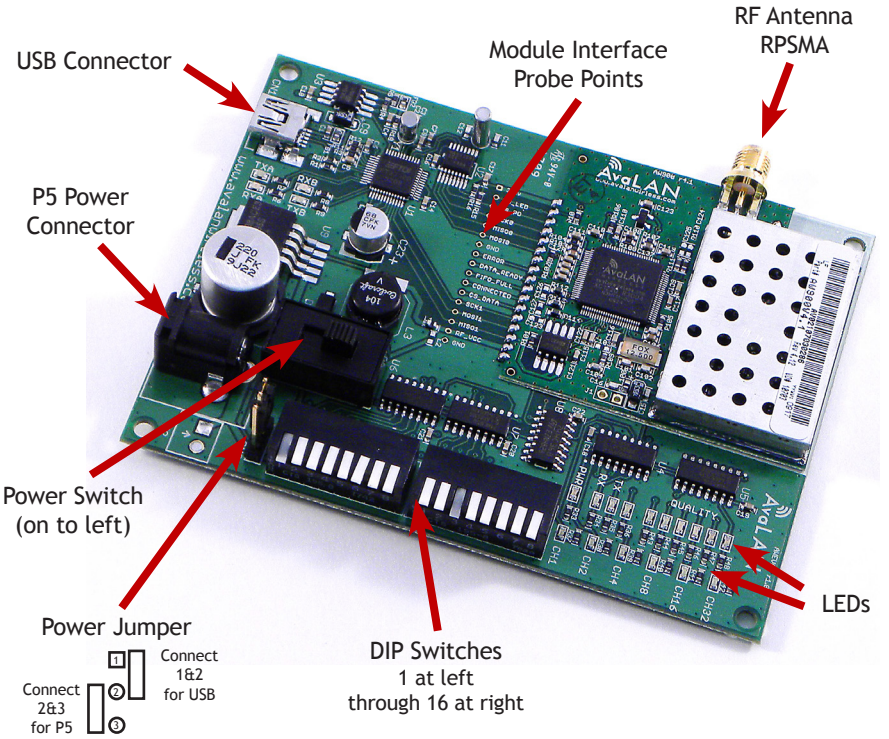


Suggested UART User Implementation:



Note that if you are using the AW900mSPI in UART mode, you may wish to include a USB interface to SPI0 similar to that implemented in the Evaluation Board. This would allow you to modify the configuration, to read back operating statistics and to perform spectrum analysis. If those capabilities are not needed, then the cost and space can be avoided.

Evaluation Board Physical Interface

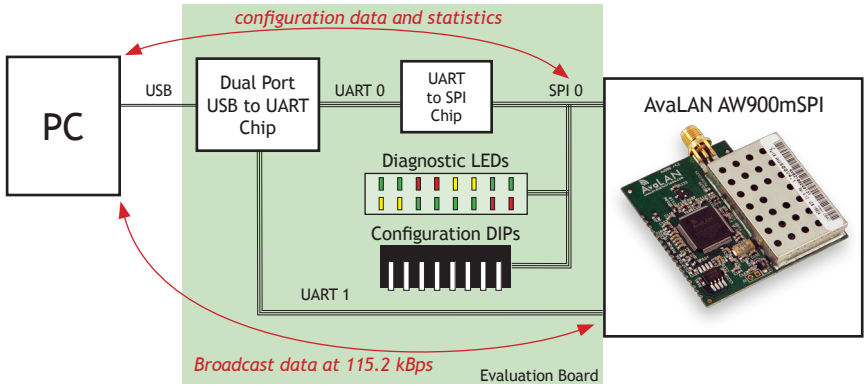


Note that the power for the USB chips is always provided by the USB port and is not otherwise switched. The power for the radio and associated parts is controlled by the power switch and may come from either the USB port or the P5 power connector, depending on the placement of the power jumper. If powered by USB, make sure that the port you are using will support attachment of a "high power" device. If in doubt or if you experience functionality issues, use the external 12 VDC adapter provided in the EVAL kit.

The probe points and LEDs are labeled on the board. The DIP switch settings:

DIP Switch Number	Off	On
1	Subscriber Unit	Access Point
2	UART Firmware Active	SPI Firmware Active
5-8	RF Channel Selection (binary coded, LSB on Left)	
11	Normal Mode	"Ping Pong" Test Mode
All Others	Not used	

Evaluation Board Block Diagram:



The Evaluation Board provides an interface to a PC via USB. A driver allows the board to be perceived as two conventional COM ports. One of these is connected through a UART to SPI chip to SPI0, the command and configuration interface in UART mode. The second COM port is logically connected to the UART port on the AW900mSPI and is used to transmit and receive data via the radio.

Note that the AW900mSPI firmware will run in UART mode only with the USB interface. If you wish to probe the logic signals in SPI mode before creating your own design, you will need to obtain an AvaLAN AW900MTR, in which the same module is interfaced to an NXP microprocessor via SPI1 with SPI0 used just for LEDs and DIP switches.

Technical Evaluation Process

Range Demonstration

The simplest test that can be performed using the Evaluation Board is an RF range test. This test allows you to verify that the AW900mSPI modules will communicate in your operating environment.

1. Choose one of the two Evaluation Units to be an Access Point. Set DIP switches 1 and 11 on (depressed) and the remainder off. Connect this unit to 110 VAC using a supplied 110 VAC to 12 VDC adapter. Do not connect the USB.

2. Configure the other Evaluation Unit as a Subscriber Unit. Set its DIP switch 11 to on and the remainder off. Do not connect the USB. You may use the supplied battery pack to power this unit if greater mobility is desired, or use the 12 VDC adapter.

3. The two radios are now configured in "ping pong" mode and will exchange data back and forth. If they are communicating, the LEDs will display a common channel, the PWR and TX lights should be lit, and up to 6 Quality lights will be lit: one red LED at the far right for minimal connectivity, two reds, two yellows, two greens for maximum RF signal strength.

4. After verifying that the radios are "ping ponging" at close range, move the units into your desired operating configuration and determine if they still have adequate signal quality (3 LEDs or more).

The signal quality will depend upon a combination of distance, interfering objects and their RF density and the antenna chosen. If your requirement is for more distance or greater penetration, consider a high gain directional antenna.

Logic Analysis Using USB and Windows Utility

By connecting the two Evaluation Boards to a PC or pair of PCs and loading appropriate software, the two radios can be programmed and the digital performance and timing can be analyzed. Note that the Evaluation Board environment is UART and if you desire a demonstration of SPI logic behavior before constructing your own host microcontroller environment, consider evaluating an AW900MTR Ethernet radio module. You may examine the logic signal timing in UART mode by attaching a logic analyzer to the labelled probe points on the Evaluation Board.

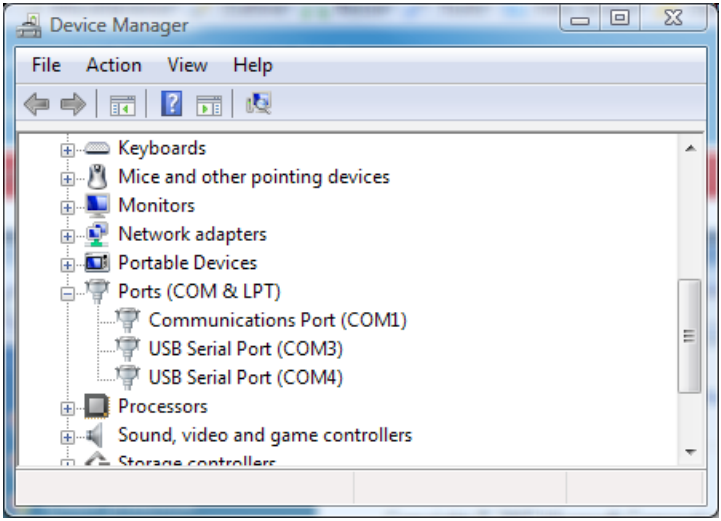
To evaluate AW900mSPI performance, you will need one or two PCs that run Windows XP or higher. It is possible to plug both Evaluation Boards into one PC, but that of course limits the RF range and may cause overloading of the radio's receivers.

To operate the AW900mSPI Evaluation Board from a PC, you will need a free USB connection per board and two critical pieces of software. The USB interface is through an FT2232D chip from Future Technology Devices. Your PC must have a driver loaded that allows assignment of two virtual COM ports that connect to this chip. Plus you will need a software utility from AvaLAN that supports configuration, status testing and data exchange.

1. **Set all DIP switches on the Evaluation Board to off (up).** Connect an AW900mSPI Evaluation Board to a USB port on your PC using the cable supplied (micro USB to standard USB). Usually, your PC will discover the new USB device and automatically load an appropriate driver. If this is successful, you will see a popup window that indicates that your new USB device is installed and ready for use. Make note of the two COM port numbers, which should be consecutive.

2. Verify that your PC is connected logically to the Evaluation Board by running the Windows Device Manager (right-click on "My Computer", select

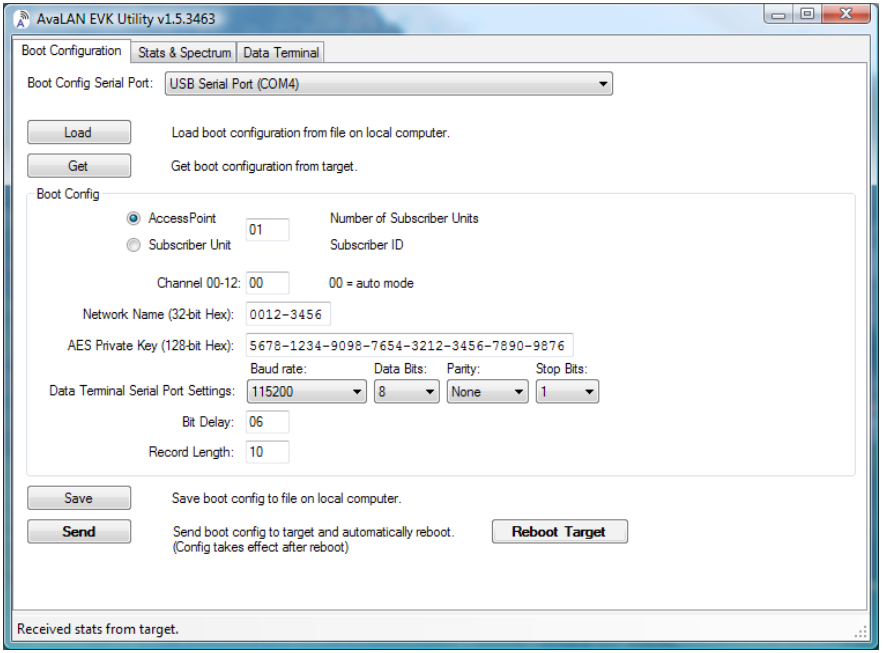
"Properties", then "Device Manager" or run the Control Panel and choose Device Manager from the choices available there). In Device Manager under the Ports item, you should see a pair of USB Serial Ports with associated COM numbers.



3. If the USB Serial Ports are there, skip this step and go on to the next. If they are not and you are sure that the Evaluation Board is connected to a USB port on your PC, then download and install the latest driver from **www.ftdichip.com**. Go to that website and find the latest driver for your operating system and for the FT2232 series of chips. Install the driver following the instructions provided by them.

4. Go to the AvaLAN website and download the latest version of the software utility for this product: **www.avalanwireless.com/sw/EVK_Utility.zip**. (Follow this link, or use the navigation menu: avalanwireless.com > Support > Documentation & Downloads, choose AW900mSPI and the EVK Utility link.) Save the zip file wherever you like. When you extract the file, it will create a folder that contains three files: EVKUtility.exe, ZedGraph.dll and EVK.conf. The utility will run from any folder on your hard drive and requires no installation or registry modification. (The .dll must be in the same folder as the .exe.)

5. Run EVKUtility.exe. You should see a window similar to that on the following page. The application window has three tabs, with the "Boot Configuration" tab appearing first.



6. The dropdown list labeled "Boot Config Serial Port" will offer a choice of all active USB Serial COM ports on your system. the one you should select is the higher numbered of the two ports associated with the Evaluation Board.

7. Next, you have the choice of loading the boot configuration from a file or retrieving it from the AW900mSPI. A sample file is provided for your convenience as EVK.conf. The configuration file is a readable and editable text file, but the easiest way to modify it is to load it with the utility, change what you wish in the set of boot configuration parameters and then save it back to your PC.

8. The Boot Config parameters are as follows:
   - Access Point (AP) or Subscriber Unit (SU) radio buttons. Set one Evaluation Board to be an AP and the other to be a SU.
   - Number of Subscriber Units if AP or Subscriber ID if SU. (An AP will support up to 16 SUs at one time and their assigned IDs should be assigned consecutively from 1 to n.) For the pair of Evaluation Boards, set both to "01".
   - Channel: a two-digit number from 00 to 12, specifying the RF channel to use or allowing automatic selection with the code 00. The AP and associated SUs must use the same channel, either automatically negotiated or set in common.

- Network Name: a 32-bit (entered as 4 hex digits) network key that must be the same for all communicating radios.
- AES Private Key: a 128-bit (entered as 32 hex digits) value that is the private encryption key used to secure the traffic sent between radios. All communicating radios must have the same assigned key.
- Serial Port Settings: the familiar parameters associated with any UART connection, baud rate, data bits, parity and stop bits.
- Bit Delay and Record Length: These are performance tuning parameters that help to optimize the match between incoming data and packet transmission in UART mode. For a complete discussion, go to avalanwireless.com/faqs.com and look for AW900mSPI Performance Tuning.

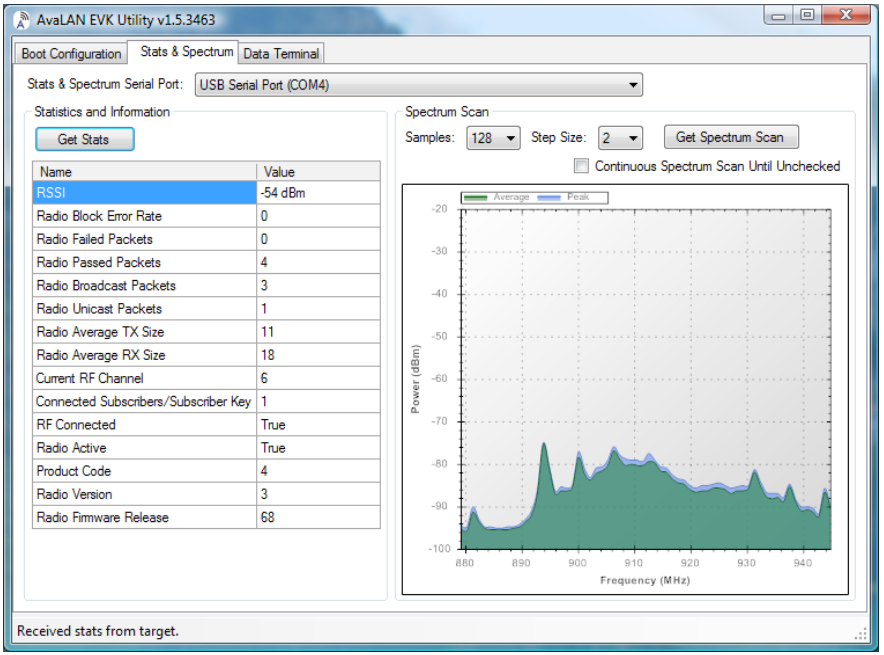
9. When you are satisified with the Boot Config parameters, you may save them to a file of your choice on your PC by clicking the "Save" button. Then, click "Send" to send the boot file to the XC1220 on the module. You should see a message indicating successful upload in the status bar at the bottom of the utility's window. The "Send" button will also cause the module to reboot. The status bar will then show "Target Rebooted." You can verify that the boot configuration parameters were successfully loaded by clicking the "Get" button and seeing no change from what was sent. The "Reboot Target" button can be used to reboot without uploading the configuration.

10. At this point, you will want to activate the second Evaluation Board by repeating steps 1 through 9 with it. If both Evaluation Boards are connected to the same PC, the COM port numbers assigned will be different. The higher numbered COM port in each pair is always the Boot Config Serial Port and the lower numbered port is used for data that is transmitted and received via RF.

11. Make sure that you can update the Boot Configuration parameters for both Evaluation Boards and that the configurations are compatible (one AP, one SU, matching channels, keys and serial port settings.

12. When both radios are configured properly, their LEDs will indicate that they are successfully communicating: Their channel LEDs will show the same binary channel number and the quality LEDs will indicate RF signal strength. If a radio is continuously scanning through the RF channels and just one red quality light is lit, the units have not successfully negotiated an RF connection and a mismatched configuration is likely to be the cause.

13. By clicking the "Stats & Spectrum" tab at the top of the utility's window, you will see a window that allows you to examine the AW900mSPI's reported status information and to perform a spectrum scan of the 900 MHz frequency band to look for interference sources:

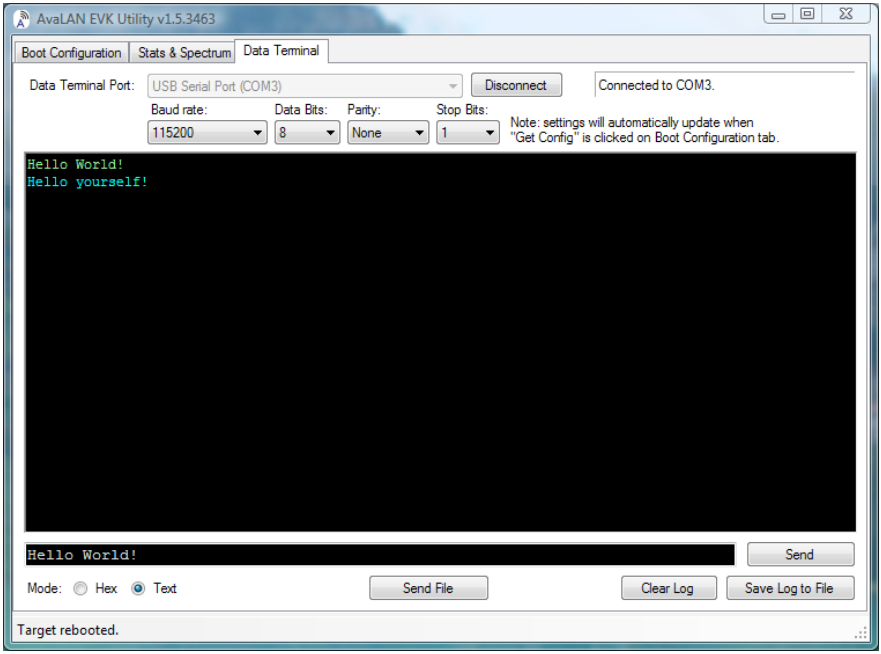


14. The Stats & Spectrum Serial Port selection should be the same as that on the previous page. By clicking "Get Stats", the radio's status information will be read from the AW900mSPI and displayed. The parameters are self-explanatory. Until you exchange data as described below, the packet counts and sizes may all be zero.

15. On the right side of the window you can cause the AW900mSPI to do a spectrum scan as described in the getRSSIReadings command explanation earlier in this manual. You can select the frequency step size and number of samples to be averaged at each frequency, then execute a single scan with the "Get Spectrum Scan" button, or continuously scan by checking the box. Continuous scanning will obviously degrade data transmission performance.

16. You should do a spectrum scan with the AP unit. Before it scans, it shuts off its transmitter and tells any connected SUs to do the same, then steps the receiver through the band. If you do a scan with an SU, you will likely see peaks of transmission from the other radios.

17. The peak and average received power at each frequency is displayed in logarithmic graphical form.



18. By clicking the "Data Terminal" tab at the top of the window, you are provided with a rudimentary means of exchanging data between the connected radios.

19. The Data Terminal Port (the lower numbered COM port associated with the radio) should be selected from the drop down box near the top of the window. Data terminal settings (Baud rate, etc.) are pre-selected here from the boot configuration. They may be overridden if desired without affecting the boot configuration. Click "Connect" to establish communication between the Data Terminal and the radio. The text box to the right of the "Connect" button should give a message verifying a successful connection. The "Connect" button now changes to a "Disconnect" button. Note that returning to the Boot Configuration tab and modifying and rebooting the radio will automatically disconnect the Data Terminal port and pop up an alert message to that effect.

20. Text or binary data mode can be selected using the Mode buttons. Data to be transmitted should be entered into the one-line black box near the bottom of the window and will be transmitted to the other radio when "Send" is clicked or the Enter key is used.

21. The "Send File" button may be used to transmit contents of a file. Please be aware that the UART interface lacks flow control and long data files will not be transferred successfully.

22. Data that is sent will appear in the large black box in green. Data that is received will also appear here in cyan. This information is also accumulated and may be saved to a file on your PC with the "Save Log to File" button. The log will be cleared and a new one started by clicking "Clear Log" or by disconnecting and reconnecting the COM port.

23. Under certain circumstances, changing the configuration after exchanging data with the Data Terminal may cause the boot config COM port to hang. When this happens, the status bar at the bottom of the utility window will show "Cannot read from target on COMx. [The operation has timed out.] If this happens, cycle power on the Evaluation unit with the black power switch on the board and try the operation again.

24. There is a second utility available called EvkUtilityLite that removes the Data Terminal functionality for those who prefer to use hyperterminal or some other application to interface with the Data Port but still need to control boot configuration and retrieve status information. Download it from our website: **www.avalanwireless.com/sw/EVK_Utility_Lite.zip.** If you activate the "ping pong" mode by turning on DIP Switch 11, you can see the statistics change as the radios exchange their random data.

Next Steps

You can connect your microcontroller circuitry to the AW900mSPI without unsoldering it from the Evaluation Board by attaching your wiring to the probe points and leaving the USB disconnected. Use DIP Switch 2 to control whether UART (off) or SPI (on) firmware is loaded at bootup or use a 10K resistor pull up or pull down on pin 8 as described in the Technical Summary on page 5.

Also available on our website are some additional resources to help you with your own product development:

- AvaLAN's driver C Source Code (for an ARM7, use at your own risk)
- Evaluation Board schematics
- Evaluation Board Gerber layout files

Just follow the links on **www.avalanwireless.com/downloads.htm**.

FCC Certification

The AW900MR OEM RF Module complies with Part 15 of the FCC rules and regulations. Compliance with labeling requirements, FCC notices and antenna regulations is required.

Labeling Requirements

In order to inherit AvaLAN's FCC Certification, compliance requires the following be stated on the device and within its operation manual:

FCC ID: R4N-AW900MR This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference and (2) this device must accept any interference received, including interference that may cause undesired operation.

Label Warning WARNING The Original Equipment Manufacturer (OEM) must ensure that FCC labeling requirements are met. This includes a clearly visible label on the outside of the final product enclosure that displays the contents shown in the figure below.

Figure A.1. Required FCC Label for OEM products containing the AvaLAN AW900MR OEM RF Module

> Contains FCC ID: R4N-AW900MR
> The enclosed device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:
> (1) this device may not cause harmful interference and
> (2) this device must accept any interference received, including interference that may cause undesired operation.

FCC Notices

Adherence to the following is required:

IMPORTANT: The AW900MR OEM RF Modules have been certified by the FCC for use with other products without any further certification (as per FCC section 2.1091). Changes or modifications not expressly approved by AvaLAN could void the user's authority to operate the equipment.

IMPORTANT: OEMs must test their final product to comply with unintentional radiators (FCC section 15.107 and 15.109) before declaring compliance of their final product to Part 15 of the FCC Rules.

IMPORTANT: The AW900MR OEM RF Modules have been certified for fixed base station and mobile applications. If modules will be used for portable applications, the device must undergo SAR testing.

NOTE:

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiving module.
- Connect the equipment into an outlet on a circuit different from that to which the receiving module is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Antenna Warning

WARNING: This device has been tested with Reverse Polarity SMA connectors with the antennas listed in Table 1 below. When integrated into OEM products, fixed antennas require installation preventing end-users from replacing them with non-approved antennas. Antennas not listed in the tables must be tested to comply with FCC Section 15.203 (unique antenna connectors) and Section 15.247 (emissions).

FCC-Approved Antennas (900 MHz)

Fixed Base Station and Mobile Applications

AvaLAN Modules are pre-FCC approved for use in fixed base station and mobile applications. When the antenna is mounted at least 20 cm (8") from nearby persons, the application is considered a mobile application.

Portable Applications and SAR Testing

When the antenna is mounted closer than 20 cm to nearby persons, then the application is considered "portable" and requires an additional test be performed on the final product. This test is called the Specific Absorption Rate (SAR) testing and measures the emissions from the module and how they affect the person.

RF Exposure

(This statement must be included as a CAUTION statement in OEM product manuals.)

WARNING: This equipment is approved only for mobile and base station transmitting devices. Antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

To fulfill FCC Certification requirements:

1. Integrator must ensure required text [Figure 1] is clearly placed on the outside of the final product.
2. AW900MR Module may be used only with Approved Antennas that have been tested with this module.

Antenna Type	Type	Maximum Gain
Omni directional	Monopole	≤ 3dBi

Table 1. Type certified Antennas:

IC (Industry Canada) Certification

Labeling requirements for Industry Canada are similar to those of the FCC. A clearly visible label on the outside of the final product enclosure must display the following text:

Contains Model AW900MR Radio, IC: 5303A-AW900MR

Integrator is responsible for its product to comply with IC ICES-003 & FCC Part 15, Sub. B - Unintentional Radiators. ICES-003 is the same as FCC Part 15 Sub. B and Industry Canada accepts FCC test report or CISPR 22 test report for compliance with ICES-003.